ON THE TEMPORAL AND MASSETER MUSCLES OF MAMMALS.

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Systematic writers have described the temporal and masseter muscles in mammals as being distinct from one another. I hope to show that they are, in the great majority of forms, parts of the same muscle.

I have found in my dissections that the temporal muscle,[1] as a rule, has a deep and a superficial set of fibres. The deep set arises from the floor of the temporal fossa, and makes up the greater part of the muscle. Most of the fibres unite to form a tendon, which is inserted upon the apex of the coronoid process of the lower jaw. Many of the fibres which do not so unite are inserted upon the median surface of the coronoid process; others again are continuous with the superficial fibres. The superficial set of fibres arise from the temporal aponeurosis. It is continuous in the main with the deep fibres of the masseter, and the fibres are inserted upon the lateral surface of the coronoid process. A partially distinct slip arising from the median aspect of the malar bone, and the ridge on the squama over the external auditory meatus, is an accession to the superficial fibres, but possesses a tendency to unite with the fibres of the deep set in the anterior portion of the fossa. These fibres may receive the name of the supra-zygomatic portion of the masseter. They are inserted at the base of the coronoid process, forming a thin glistening tendon within and a little posterior to the anterior border of the body of the masseter. The supra-zygomatic slip is merged with the large superficial mass in the dog.

I believe that I have detected as part of the general plan of the masseter muscle, when well developed, that it is composed first of a tendino-muscular layer, rising tendinously from the anterior part of the zygoma or the maxilla near the infra-orbital foramen, and is inserted muscularly into the angle; second, of a nearly vertical layer, tendinous below near the angle, muscular near the zygoma; third, of a nearly vertical layer, having a disposition to become tendinous, both near the angle and at the malar bone; fourth, of a smaller layer occupying the fossa on the lateral surface of the ramus, and which exhibits a glistening layer of

[1] For convenience the temporal and masseter will be held as distinct in the descriptions.

tendon at the origin from the malar bone. The fibres beneath this are continuous, in most mammals, with the superficial layer of fibres of the temporal muscle, including the supra-zygomatic slip, which, in some animals, is distinct in great part from the fibres arising from the temporal aponeurosis. The masseter presents a general resemblance to the internal pterygoid muscle, which, wherever exampled, has shown these imperfect attempts at planal cleavage.

This outline being borne in mind, it may be well to turn to the descriptions employed by writers on comparative anatomy.

The descriptions of the muscles in Meckel (Vergleich. Anat., iv, 495) are very general. The temporal is said to be covered by a conspicuous aponeurosis; the muscle to be more or less fan-shaped, and gradually narrowed from above downward. The masseter is said to be divided ordinarily into an outer, longer, stouter and straight layer and an inner, shorter, weaker layer, in which the fibres are more or less obliquely placed from above downward and before backward.

Cuvier (Leçons d'Anat. Comp., 2d Ed., iv, 1me Part, 64 *infra*) describes the temporal in the apes, bats, insectivora, rodents, two-toed ant-eater, hog, ruminants and the cony. None of these includes the arrangement of fibres above given. It is true that in the ant-eater the masseter and temporal muscles are united, but no detail of the character of the union is presented. Mivart (Elements of Anatomy, 310) repeats this statement. It is evident that the union of the muscles is here thought to be exceptional. Cuvier and Laurillard further describe the masseter in the bats, rodents, artiodactyles, ant-eater and the cony as composed of two portions, a zygomatic and a maxillary. The former is present in all; the latter is seen in the rodents, artiodactyles, the ant-eater and the cony.

Mivart (l. c., p. 309) describes the masseter in *Lagostomus* and *Dasyprocta* as follows, as of "great development:" "The masseter is divided into three portions, and traverses the singularly enlarged infra-orbital foramen spoken of in describing the skeleton." According to the interpretation used in this paper, the masseter in rodents has even fewer subdivisions than in some other mammals. Of these, at least one only passes in such direction as to permit the expression that it "traverses the infra-orbital foramen;" and this part is not separable from all the fibres lying on a plane lower than that of the zygoma.

The descriptions of Cuvier and Laurillard of animals I have not dissected, may be here epitomized:

In the horse a small superficial slip of the temporal exists, which does not conceal the main tendon.

In the lion (Pl. 143 and 144, fig. 2) the parts marked *vertico-soutien* and *jugo-soutien* answer in position to the superficial and supra-zygomatic fasiculi. The slips are identified, however, with the muscles of the external ear.

In the description of the myology of *Erinaceus ecaudatus* the authors use the following language: "Between the crotophytæ (temporal) and the masseter muscles in the position of the absent malar bone a red muscle-fasicle is seen, which we have been unable to identify. It is lost posteriorly upon the temporal aponeurosis, and passes under the masseter to be inserted upon the anterior border of the ascending ramus of the mandible."

I do not hesitate to classify this slip with the supra-zygomatic slip of the masseter (see fig. 2, Pl. 77 of C. & L.). Nothing to invalidate such identification can be presented excepting the fact that the slip has an alleged origin from the temporal aponeurosis. It is in every way likely that either the glistening main tendon or the aponeurotic texture of the superficial portion of the temporal is here described.

In the above descriptions no mention is made of the union of temporal and masseter except in the ant-eater, and in none is the method of description the same as employed in this paper.

In making the dissections it was found convenient, after preparing the superficies, to dissect the masseter as far as the retention of the zygomatic arch in position would permit. Then this arch was sawn through at either end, and turned down. This exhibited the continuity of the fibres attached to it, and the temporal. The latter muscle was then studied carefully. After this the head was sawed through from right to left vertically (frontal cut) in order to expose the arrangement of fibres on the median aspect of mandible in rodents, or, in lieu of this, an antero-posterior section was made.

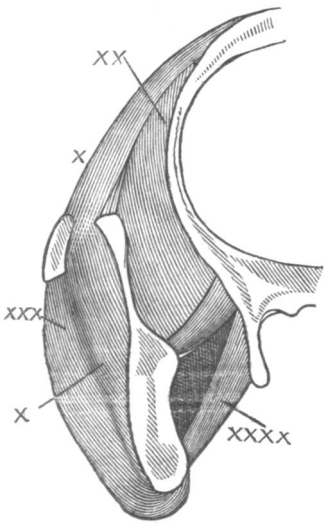
Attention will now be invited to the detailed arrangement of the parts in different mammalian types.

In *Macacus nemestrinus* we find the fibres of aponeurotic origin (superficial fibres) arising as in man. In addition, a slip of fibres, arising from the inner surface of the malar bone and the occipital crest, passes forward and obliquely downward, to be continuous with the deep masseteric fibres. This slip is the supra-zygomatic, and is believed to be an upward prolongation of the deep

masseteric fibres. It joins the superficial fibres on a line with the coronoid process. The deep fibres furnish a brilliant tendon, which extends forwards quite to the orbito-temporal septum; thus differing strikingly from the arrangement in man. The deep fibres are further seen to be imperfectly differentiated from the internal pterygoid muscle.

The masseter muscle is composed of the following:—1st. A layer arising aponeurotically from the anterior third of the zygomatic arch, and passing obliquely downward and backward to the angle. 2d. A layer resembling the foregoing; it arises from the zygomatic arch at its middle. The fibres are nearly vertical and end tendinously at the angle. 3d. A layer arising tendino-muscularly from the posterior third of the zygomatic arch. Its fibres are inserted upon the upper half of the ascending ramus of the lower jaw. These layers merge anteriorly; indeed, are indistinguishable at the anterior border.

FIG. 1.



Transverse section through masseter and temporal muscles (one inch behind the eye), *Canis familiaris*.
X, Superficial temporal fibres.
XX, Deep temporal fibres.
XXX, Superficial masseterio fibre, separated from *X* by a tendinous sheet.
XXXX, Internal pherygoid muscle, cut transversely.

In the dog the superficial fibres are much better developed than in either the macaque or man, and cover in the deeper fibres, while they do not form at any part a supra-zygomatic slip; the general arrangement of both temporal and masseter muscles as in other mammals. The masseter exhibits six cleavages, of which the last or deepest occupies the fossa on the outer surface of the ramus, and is directly continuous with the superficial fibres of the temporal (fig. 1).

In the coati, *Nasua narica*, the superficial fibres, as in the dog, completely conceal the deep fibres. The supra-zygomatic slip is beautifully distinct. Branches of a conspicuous venule which can be seen lying upon the superficial portion disappear abruptly as they approach the upper border of the supra-zygomatic slip. Subsequently dissection detects the trunk

of this vein lying between the masseter and temporal masses, behind the zygoma. The central tendon is thicker at the root of the zygoma and the bone over the external auditory meatus than any other locality in the temporal fossa.

The masseter has fine layers, closely resembling those in the dog. The deepest layer, namely, that one whose fibres occupy the ramal fossa, has a much thicker aponeurosis than the other layers, the anterior portion of the first alone excepted.

In the opossum, *Didelphys virginianus*, the superficial fibres of the temporal are everywhere thick. The aponeurosis is well developed. The supra-zygomatic slip is not distinct. The deep portion of the muscle exhibits a white glistening tendon, which does not, however, extend as far as the orbito-temporal septum. The anterior portion of the muscle is made up as is usual by the union of the deep and superficial portion. In addition to its forming the slip passing down to the front of the base of the coronoid, it sends a powerful bundle to the median side of the coronoid, a thin movable layer of muscular tissue, which passes in front of the coronoid, between the medio-coronoid and pre-coronoid portions.

The masseter is highly tendinous superficially. The tendency to cleavage is not pronounced, and the continuity of the deep fibres with the superficial fibres of the temporal is very noticeable.

In the squirrel, *Sciurus hudsonicus*, the superficial portion of the temporal is less distinct than in man, and the supra-zygomatic slip, while demonstrable, is not large. The superficial tendinous layer of the masseter arises from a spur on the maxilla below the infra-orbital foramen. It passes, as is usual, downward and backward toward the angle. This layer does not, as in most mammals, form the entire superficies. A second layer arises from entire inferior border of the zygoma, which appears to be lost upon the foregoing about midway between the zygoma and the angle. Upon turning this last layer downward, the third and last layer is seen, which is continuous in the ordinary manner with the temporal fibres. The arrangement of fibres on the median surface of the mandible was not examined.

In the North American porcupine, *Erethizon dorsatus*, the masseter consists of a superficial set of fibres arising tendinously from the malar bone, and passing downward and backward to the angle of the mandible. It arises from the anterior three-fourths

of the lower border of the malar bone, the entire lower border of the enormous infra-orbital foramen. Its insertion is not only upon the angle but the median surface of the ramus as well. The last-named insertion occurs as follows: The anterior edge of the muscle becomes stout and broad as it approaches the rounded border of the bone in front of the angle. It winds round this border, receiving as it does so a large accession from the angle, and a portion of the adjacent median surface from the lower jaw. This portion of the masseter lies below the jaw on the soft parts of the neck. In addition to the above, a long, stout, fusiform belly is inserted by fleshy fibres at a point half way up the ramus in front, and above the upper border of the insertion of the internal pterygoid muscle.

Beneath the superficial fibres just described, the masseter in *Erethizon* exhibits the usual tendinous fibres arising from the angle and passing upward and forward. The third set is of great importance in this animal. It agrees with the general plan of arrangement in other mammals examined, but is remarkable for its extent. It arises from the lower and median border of the zygoma by tendinous fibres, from the side of the maxilla, at the nasal region and supra-orbital surface of the same bone by fleshy slips, also fleshy from the upper concave border of the zygoma, where fibres form the supra-zygomatic slip; tendinous and fleshy from the anterior and lower half of the inner wall of the orbit. The insertion of this set of fibres is upon the ramus, between the angle and the sigmoid notch. The anterior part of the insertion is rounded and tendinous. It lies beneath the corresponding border of the surperficial portion, and receives the fibres passing through the infra-orbital foramen. The remaining portions unite to be inserted as already indicated.

The temporal muscle possesses a superficial portion, which everywhere covers in the main muscle. Its aponeurosis arises from the vertex, the upper border of the posterior half of the orbit and the posterior and upper half of the inner wall of the same depression. It thus covers in the post-orbital process of the frontal bone. It is inserted entirely upon the main tendon, and receives no fasiculus from the masseter. The deep or main portion extends its aponeurosis forward, to be inserted stoutly upon the post orbital process of the frontal bone. A thin aponeurosis passes downward, thence to the mandible behind the coronoid.

It will be seen that the plan of the muscles is the same as in other mammals, but is remarkable for the muscles' subdivisions remaining distinct from one another. In rodents having the large infra-orbital foramen, the masseter muscle is described as having a separate portion passing there through. Mivart, in his Elements of Anatomy, page 309, says, in this connection: "In certain rodents, *e. g.*, *Lagostomus* and the Agouti, the masseter divides into three portions, and traverses (that is, one of these portions traverses) the singularly enlarged infra-orbital foramen." This is a correct expression of the view usually taught. According to the plan of description followed in this paper the masseter of *Erethizon* in nowise differs from the muscles of the same name in other mammals, except in the extent of development of the layer to which the pre-foraminal fibres belong. I have had no opportunity of examining *Lagostomus*, but it is probable that the masseters are much alike in all. The porcupine is further of interest in the extent of encroachment of the muscular fibres upon the orbital space. Both masseter and temporal appropriate large surfaces. It is noteworthy in addition to find that the post-orbital process is here purely muscular in significance. It is, indeed, *imbedded* in muscle. Notwithstanding its size, the process has no septal significance in this rodent.

In *Cœlogenys* the temporal is thin in the temporal fossa but thick and massive on posterior wall of the orbital space. The superficial layer and supra-zygomatic slip are distinct. Raising these two portions of the temporal from the temporal fossa no muscular fibres are seen beneath. A distinct tendon becomes visible, however, underlying the junction of the superficial and supra-zygomatic portions. In the orbital space the superficial portion is exceedingly robust and extends medianly the entire depth of the posterior wall. The temporal is inserted into the lower jaw as follows: The superficial portion arising from the temporal fossa, and the zygomatic portion are inserted through the main tendon upon the apex of the coronoid process; the orbital portion upon the median side of the same tendon and the median surface of the coronoid its entire length.

Comparing the plan of this muscle to the others described it may be said that the deep part of the muscle is absent, unless the greater bulk of the orbital portion is assigned to the deep part. It has been generally found that the deep and superficial portions

are continuous anteriorly. It is probable that while the deep part is absent from the temporal fossa proper, it remains in position in the orbital space at a point answering to the post-septal depression in animals having a partition between the orbit and the temporal fossa. But while the deep part is absent from the proper temporal fossa, a stout glistening tendon is here in the usual position of the central tendon, and, as in *Erethizon*, is concealed from without. It is interesting to note that the supra-zygomatic slip is temporal, it being doubtful whether any of its fibres are continuous with the masseter.

The masseter bears a general arrangement to the muscle in *Erethizon*. The anterior edge is less muscular than in the latter genus. The mandibulo-zygomatic portion, whose origin from the mandibular angle occupies the lower one-third of the surface, constitutes the massive fleshy belly. The fibres are for the most part nearly horizontal. It is covered for the upper half of its surface by the enormous malar bone. The slip from the median surface of the mandible is arranged as in *Erethizon*. It lies in part in front, and in part beneath the internal pterygoid. Its junction with the main body of the masseter conceals the tendinous anterior edge thereof and is continuous with those fibres arising from the angle and the basal third of median surface. The deep mandibulo-maxillary portion is as in *Erethizon* in all essential features. It is continuous with the superficial parts. A thin layer of orbital fibres overlies the temporal muscle in the orbit. Another layer is apparently continuous with the buccinator.

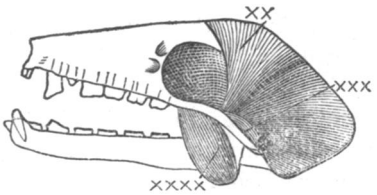
In *Dasyprocta* the general plan of arrangement seen in *Cœlogenys* is followed. The minute points of distinction therefrom not being noteworthy save the continuance of the main tendon within the orbital space, where it overlies the deep anterior vertical fibres.

In Cuvier and Laurillard (Pl. 245) the slips of the temporal are represented as parts of a bi-peniform muscle. I find the supra-zygomatic fibres more horizontal in position, darker in color and more convex than the remainder of the muscle.

In the bats the superficial portion of the temporal may be small or well developed. In the first variety a good example is seen in *Phyllostoma hastatum* and other American leaf-nosed bats in which forms the superficial portion is confined to the anterior fourth of the temporal fossa. The supra-zygomatic slip is also very

conspicuous. In *Artibeus* the superficial fibres occupy the anterior half of the fossa. In *Desmodus* the fibres are confined to the anterior portion of the fossa; they are weak and unimportant. The supra-zygomatic slip overlies the tendon of the main muscle above the zygoma. In *Lonchoglossa* the muscle is poorly developed throughout. The superficial fibres are reduced to mere rudiments. The supra-zygomatic slip is present. The deep portion does not reach the vertex.

FIG. 2.



The temporal and masseter muscles in a Fox Bat (*Epomophorus*).

XX, Superficial fibres of same.
XXX, Supra-zygomatic slip of masseter muscle.
XXXX, Masseter muscle.

The muscles in Pteropine bats resemble those in the American leaf-nosed forms. The superficial fibres are confined to the anterior third or half of the temporal fossa as seen in *Pteropus medius*, *Epomophorus* and *Cyonycteris amplexicaudata*. The supra-zygomatic slip is relatively smaller than in the Phyllostomidæ.

In *Megaderma frons* and *Phyllorhina bidens* the parts bear a general resemblance to the above group. The supra-zygomatic slip is absent in the latter species.

In *Molossus* the superficial fibres are enormously developed, they entirely cover the deep, and arise from a continuous osseous surface at the vertex which, being broad anteriorly, narrows gradually toward the occiput. The fibres arising from the vertex-crest, when such is present, are those belonging to the superficial set. The supra-zygomatic slip is present. A similar arrangement is seen in *Noctilio*, in which form the main mass of fibres possess an unusually deep set central tendon, and the superficial layer extends backward along the line of the vertex to the occiput. *Lasionycteris*, *Atalapha*, *Vesperus* and *Vesperugo* have an arrangement of the temporal fibres similar to the above but vary in the degree of development of the anterior slip.

To sum up the knowledge possessed of the temporal muscle in the Chiroptera it may be said that the deep portion is most exposed in *Pteropus* and its congeners, and the family Phyllostomididæ, owing to the small development of the anterior fibres. In Vespertilionidæ and Molossi the deep portion of the temporal

is more concealed owing to the greater development of the anterior fibres. Those in *Noctilio* appear to be directly continuous with fibres arising from the occipital crest and inserted on the outer surface of the main tendon. With respect to the masseter it may be said to be simpler than the typical description given at the beginning of this paper. It possesses but slight tendency to planal cleavage.

In the bovine type of the ruminants as seen in the head of a calf the first or superficial layer of the temporal is continuous with the masseter as shown in the above forms, the deep layer is much less conspicuously developed than in them. The temporal fossa being shallow—and not high—the central tendon is produced backward and is relatively small and insignificant. It is not traceable over a short distance beyond the top of the coronoid.

The masseter muscle possesses six layers. The first is broad and attached to the superior maxilla by an oblique line extending the entire distance from the inferior border of the orbit to the gum line over the first molar. The second arises tendinously from the angle of the lower jaw and extends obliquely upward and forward, half way up the ascending ramus. The third layer is tendinous at the anterior superficies of the malar bone, the fibres arising thence including the anterior half of the surface of the zygoma. The fourth layer arises from the inferior border of the zygoma at its anterior two-thirds, and is inserted muscularly upon the ramus about midway between the zygoma and the lower border of the mandible. It is this layer which is continuous with the temporal as in other quadrupeds.

The masseter exhibits a fifth slip which appears to be a differential from the second or third layers, it overlies the temporomaxillary articulation in the form of a well-defined bundle which arises tendinously from the root of the zygoma. It is inserted on the ramus near the posterior border at about its middle. A sixth layer exists in the form of a narrow, bright tendon and associated fibres arising from the root of zygoma beneath the foregoing.

Nothing similar to the fifth and sixth layers were seen in the other animals examined. The sixth layer of the dog being rather a sub-division over the ramus in front of and remote from the joint. It is every way likely, however, that the number of the layers in

masseter will be found to be variable. The parts in the masseter of the Virginian deer (*Cariacus virginianus*) presented essentially the same features as in the calf. The superficial layer of the temporal resembles that of the calf, but the main tendon is small and is without muscular fibres, as it lies behind the orbito-temporal septum. The superficial portion is small. It lies behind the coronoid, in the posterior superior portion of the temporal fossa.

It must be said that the human anatomist seems warranted in treating the masseter and temporal muscles distinct. Quain, indeed, affirms that some of the posterior temporal fibres arising from the temporal fascia blend with the deep fibres of the masseter, but the union of the muscles in man is a rare anomaly. Macalister (Muscular Anomalies in Human Anatomy. Trans. of the Royal Irish Academy, xxv, 1872, 18.) has met with it but once. I have seen it once only.[1] No mention is anywhere made of the presence of the supra-zygomatic slip. It is quite likely that it may be occasionally seen in the cellulo-adipose tissue above the zygoma. Of the presence of any peculiarities in the anthropoid apes in these muscles I am uninformed.

The arrangement of the superficial layer of the temporal muscle in man is very similar to that seen in the quadruped. This layer arises from the temporal aponeurosis, and while thin posteriorly is thick anteriorly, behind the orbital septum. If this layer of fibres be divided posteriorly and the anterior portion turned forward, a thick radiated tendon is displayed beneath. This is the tendon of the deep set of fibres which here as in quadrupeds constitute the mass of the muscle. The fibres of the superficial and deep sets are continuous behind the orbital septum. This method of displaying the temporal muscle has been for many years employed by Prof. Joseph Leidy in his demonstrations at the University of Pennsylvania.

From the above examination I have come to the following conclusions:—

(1) While it is convenient to separate these muscles it must be remembered that in many mammalia the tendency is for the masseter and temporal muscles to unite—the deep part of the former being continuous with the superficial part of the latter.

[1] In a dissection of the muscles in a mulatto child at term, I found the deeper plane of masseteric fibres arising from the external surface of the temporal tendon.

(2) Man, and some of the Rodents—the latter illustrated in *Erethizon*—are exceptions to the tendency. In these forms the temporal is distinct from the masseter. In the same order, as in *Cœlogenys* and *Dasyprocta*, the deep portion of the temporal is either absent or represented in a single orbitally disposed mass of vertical fibres.

(3) The muscles in question have been much neglected. They should be carefully dissected in all myological studies of the mammalia.